SCIENTIFIC NOTE

Escape behaviour of cranberry girdler, *Chrysoteuchia topiaria* (Lepidoptera: Pyralidae), moths

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Chrysoteuchia topiaria (Zeller) (Lepidoptera: Pyralidae), the cranberry girdler, is a serious pest of cranberry, *Vaccinium macrocarpon* Aiton (Ericaceae), in North America (Kamm *et al.* 1990). *Chrysoteuchia topiaria* is univoltine, with moths emerging and flying in June and July (Kamm *et al.* 1990). The moths are day-fliers, but also come to light traps at night (Banerjee 1967).

When collecting gravid female *C. topiaria* moths for a laboratory colony, I observed that females were hard to catch because they behaved differently than males. When I approached with a handheld vacuum (Bioquip, Gardena, CA), female moths often dropped from plants, whereas male moths usually flew away. Moths that dropped landed on the trash layer (shed leaves and organic debris on the soil surface under the vines) where they lay motionless on their side until pursued further, when they scurried away by pushing the substrate with their legs.

To test the hypothesis that female *C. topiaria* moths respond to disturbance differently than males, escape behavior of male and female moths on a cranberry farm (cv. Stevens; 49°13'50.0"N, 122°43'33.0"W) was observed and recorded. Disturbance was defined as movement of the handheld vacuum toward the moth. Movement of the vacuum was often accompanied by a high-pitched crunching sound made by compression of cranberry vines underfoot. Observations were made by a team of two people between 1030-1230 h Pacific Daylight Time, on 28 and 29 June and 12 and 27 July 2000. An observer spotted a moth and kept it in view while a collector approached it with the handheld vacuum. The team followed the moth for five flights or until the moth dropped to the ground, whichever occurred first. The observer marked with a survey flag the locations where the pursued moth alighted or dropped. After the collector caught the moth, the observer recorded the number of flights and measured the distance between each set of flags to calculate the total distance flown. Air temperature was recorded by a shaded Hobo datalogger (Onset Computer Corp, Bourne, MA) and windspeed was recorded by the farm's anemometer. Captured moths were kept cool and transported to the laboratory, where females were dissected for spermatophores. Data are presented as mean ± standard error of the mean unless otherwise specified. Statistical tests were done with Systat 8.0 (SPSS Inc., Chicago, IL).

When disturbed, 37% of females ($n = 33$) dropped from the vines into the trash layer, in contrast to only 6% of males ($n = 34$) ($\chi^2 = 9.4$, $P = 0.002$). The median number of flights made by males was greater than that made by females (5 vs. 4; Mann-Whitney $U = 362$, $P = 0.007$). The median distance flown, measured for 27 males and 27 females, was 2.5 times greater for males (5.0 vs 2.0 m; Mann-Whitney $U = 213$, $P = 0.009$). Most (31) of the 32 captured females had mated at least once: 13 contained one spermatophore, 14 contained two, and 4 contained three. The number of spermatophores in females that dropped was similar to the number in females that did not drop (1.5 ± 0.2 vs. 1.8 ± 0.2; two-sample $t_{30} = 1.1$, $P = 0.3$).

Female moths seemed larger than males. To test the hypothesis that females' wing

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load was greater than that of males, captured moths were weighed (before dissection) on a microbalance accurate to 0.01 mg (Sartorius Canada Inc., Mississauga, ON) and their wings were removed for area measurement by Scion Image software (Scion Corporation, Frederick, MD). To calculate total wing area, the areas of the most intact forewing and hindwing were measured, added together, then multiplied by two. Wing load was calculated by dividing moth weight by total wing area. Two-sample, one-tailed t-tests were used to analyse weight, wing area and wing load of females vs. males.

Females weighed more than males (13.96 ± 0.71 vs. 9.33 ± 0.44 mg; $t_{64} = 5.6$, $P < 0.001$) and had larger abdomens. Wing area of females was similar to males' wing area (96.51 ± 2.49 vs. 93.57 ± 1.96 mm^2; $t_{63} = 0.9$, $P = 0.4$). Wing load was 0.15 ± 0.01 mg/mm^2 for females, and 0.10 ± 0.01 mg/mm^2 for males ($t_{63} = 5.5$, $P < 0.001$). The wing load of females that dropped was not different than the wing load of females that flew (0.13 ± 0.01 vs. 0.15 ± 0.01 mg/mm^2; $t_{30} = 1.2$, $P = 0.2$). There was no relationship between dropping and windspeed, which ranged from 2.7-13.6 km/h ($F_{1,2} = 0.5$, $P = 0.6$) or between dropping and temperature, which ranged from 20-28 °C ($F_{1,2} = 0.3$, $P = 0.6$).

To take off and maintain flight, wings of female *C. topiaria* moths must lift about 50% more body weight per unit area than male wings, thus the physiological cost of flight should be greater for females. A more extreme example of differences in wing load and flight behaviour is reported for the grasshopper *Phymateus morbillosus.* Females have large, heavy abdomens and wing loads three times greater than males; females escape by remaining motionless or hopping away to hiding places, whereas males take flight (Gade 2002). When thrown into the air by experimenters, females did not produce lift and simply plummeted to the ground (Gade 2002).

Both types of escape behavior (dropping or flying) put moths at risk of predation. Swallows, which prey on flying *C. topiaria* (Scammell, 1917), would catch males and mated females that had laid many eggs. Terrestrial predators, such as the hunting spiders commonly found in cranberry fields (Fitzpatrick *et al.* 1994, Bardwell and Averill, 1996), would likely prey on female moths that drop from the vines.

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